ARS 52-19
March 1967

LAYOUT GUIDELINES FOR PEACH PACKINGHOUSES

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

Prepared by

Transportation and Facilities Research Division
Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

In Cooperation With

College of Agriculture Experiment Stations
UNIVERSITY OF GEORGIA

PREFACE

This report is the first of a group to be issued on the results of research conducted for the purpose of reducing marketing costs for peaches by developing improved methods, equipment, operating procedures, and facilities for preparing fresh peaches for market. This will permit the grower-packer to obtain an adequate return on his investment while supplying the consumer with a high quality peach at a reasonable price.

This study was conducted under the general supervision of Joseph F. Herrick, Jr., investigations leader, and A. H. Bennett, agricultural engineer, Handling and Facilities Research Branch, Transportation and Facilities Research Division, Agricultural Research Service, in cooperation with the University of Georgia, Department of Agricultural Engineering.

The author wishes to thank the packinghouse operators in Georgia and South Carolina who made their facilities available for study.

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LAYOUT GUIDELINES FOR PEACH PACKINGHOUSES

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SUMMARY

Facilities, equipment, work methods, and operating procedures prevalent in commercial peach packinghouses in Georgia and South Carolina were evaluated. Factors that should be considered in planning peach packinghouse layouts were determined, and a systematic layout procedure was developed. This procedure was used to develop layouts for three synthesized peach packing operations. The layout examples incorporate equipment, work methods, and operating procedures typical in the industry and illustrate basic plant layout principles. The layouts are similar in many respects, but the equipment and location of certain in-plant areas vary. All three layouts provide the flexibility of packing peaches in baskets or boxes and can be used in enclosed buildings of conventional design or in open sheds.

Each layout example was designed to satisfy specific operating criteria. Layout A was designed with future expansion in mind. It permits starting out with a one-line operation having a capacity of 350 bushels packed per hour, and adding a second line in the future to increase the capacity to 700 bushels per hour. Peaches are dumped onto a moving belt at the head of the packing line and hydrocooled in a flood-type hydrocooler after packing. Layouts B and C each have a capacity of 450 bushels packed per hour and peaches are hydrocooled in a bulk hydrocooler before packing. In layout B, peaches are dumped at the head of the packing line by a hydrodumper. Layout C provides the capability of packing peaches of either of the two smallest sizes into a consumer pack without interrupting other plant operations. A refrigerated storage facility permits accumulating a backlog of packed peaches, thus allowing a considerable degree of flexibility in operating and shipping schedules.

Peach packinghouse operators can develop layouts that are efficient, flexible, and economical to operate by following the layout procedure and adapting those features of the layout examples that meet their particular needs.

INTRODUCTION

Fresh peaches are a perishable commodity and must receive proper handling throughout the marketing cycle to reach the consumer in good condition. An increasing consumer demand for fine quality peaches during the past few years is causing a shift in emphasis within the peach industry from quantity to quality production. Experience and research on the physical and

physiological aspects of handling peaches have resulted in innovations in handling methods, equipment, packing materials, and conditioning processes that permit packing high quality fruit and maintaining that quality throughout the marketing cycle.

Many packinghouse operators have been unable to incorporate these innovations into their operations because of inadequate space or because the cost of modifying their premises would be prohibitive. This is primarily because their facilities were designed for marketing conditions prevailing at the time the facilities were built, without adequate provisions for expansion, modification, and operating flexibility. Often, new equipment is obtained and placed in the packinghouse wherever space is available. But improper placement defeats the purpose of the improvement, because it lowers the overall operating efficiency of the packinghouse.

This study was undertaken to develop guidelines for planning peach packinghouse layouts that will allow more efficient and flexible operations. Facilities, equipment, conditioning processes, work methods, and operating procedures of 20 commercial peach packing operations in Georgia and South Carolina were studied. Factors that should be considered in layout planning were determined and a systematic layout procedure was developed.

To illustrate the principles of layout planning, three layouts were developed; each permits packing peaches in either baskets or boxes.[1] There has been a decrease in use of the basket in recent years, but it is not likely to be replaced entirely in the near future. The ability to pack either type of container provides a considerable amount of operating flexibility and very little additional equipment is required to achieve it.

Layout A has a capacity of 350 bushels packed per hour and provides for doubling this capacity by addition of a second packing line. The peaches are hydrocooled after they are packed. Layouts B and C have capacities of 450 bushels packed per hour; production can be increased by increasing the hours of plant operation. In layouts B and C, peaches are hydrocooled before they are packed, and layout C provides for packing small peaches into consumer packs. Layout C also has a refrigerated storage capable of holding 120 40- by 48-inch pallets using 2-high stacking. With each pallet holding forty 3/4-bushel wirebound boxes, the room has a capacity of 3,600 bushels of peaches.

Laboratory tests and some commercial scale tests have indicated that carefully controlled heat (hot water) treatment of peaches can reduce postharvest decay.[2] Extreme care must be exercised to keep the peaches from being reinoculated with decay organisms after treatment. Anyone contemplating use of the hot water treatment of peaches should contact the Market Quality Research Division, U.S. Department of Agriculture, Federal Center Building, Hyattsville, Maryland 20782. If the hot water treatment is installed, it should follow immediately after the pregrading operation.

A relatively new development in the peach industry is the use of pallet boxes instead of field boxes for handling peaches from the orchard to the packinghouse. However, currently available devices for dumping peaches from pallet boxes at the head of the packing line are not entirely satisfactory. Further research is necessary before use of pallet boxes for peaches can be recommended.

Every plant layout should be based on specific operating conditions; therefore, the layout examples given here are applicable only for operating conditions identical to those specified for each layout. They can, however, be used as guidelines for planning any packinghouse layout. Packinghouse operators can plan layouts that are efficient, flexible, and economical to operate by following the layout procedure and adapting those features of the layout examples that are applicable to their particular needs. This will provide consumers with adequately conditioned, damage-free fruit at a reasonable price and permit the grower-packer to obtain an adequate return on his investment.

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[1] In this report boxes refer to any of the several widely used types of rectangular containers in which 25 or 38 pounds of peaches are jumble-filled. Baskets refer to the standard 1/2- or 3/4-bushel basket.

[2] Smith, W. L., Bassett, R. D., Parsons, C. S., and Anderson, R. E. Reduction of postharvest decay of peaches and nectarines with heat treatments. U.S. Dept. Agr. Mktg. Res. Rpt. 643, 24 pp. 1964.

SYSTEMATIC LAYOUT PROCEDURE

Plant layout is the arrangement of space, work areas, and equipment within a production facility. Layout planning aims at coordinating the use of men, machines, materials, and their supporting activities to obtain a product at a cost low enough to sell at a profit in a competitive market.

The layout of a plant should be developed before the plant structure is planned, as it is easier to position a building around a layout than to position a layout into an existing building. Often, new layouts must be planned or old ones modified to fit into existing structures. This imposes certain restrictions, but the basic layout principles are the same. There are certain factors that should be considered and a systematic procedure that should be followed in planning the layout of any production facility. This procedure and these factors, as they relate to peach packinghouses, are described in the following discussion.

Product Analysis

Determining the production capacity of the packinghouse--product analysis--is the first step in the layout procedure. Both the present and future annual volumes of product should be considered so that operating flexibility and provisions for expansion can be incorporated in the layout.

Present and future annual volume, or the quantity of peaches to be packed during a season, are determined on the basis of the following factors: (1) Number and varieties of trees in production; (2) yield per tree; (3) age of trees; (4) tree replacement schedules; and (5) future production plans.

Present and future hourly production rates are based on the annual volume and the following factors: (1) Number of hours per year the packinghouse will operate; (2) average maturity date for each peach variety; (3) availability of labor; and (4) shipping schedules. The hourly production rate is minimized by planting tree varieties that mature at intervals, so that when one variety has been harvested and packed, another variety will have reached maturity. This tends to provide a uniform flow of fruit to the packinghouse throughout the season, permitting efficient utilization of facilities and equipment.

Operation Analysis

Some peach packing operations are standard and others are optional. After the packinghouse operator decides on the operations he will use, he should analyze them to determine the sequence in which they are to be performed. Operation analysis can be effectively accomplished by using a chart which shows the sequence of all operations, inspections, and storages of the product. A chart for a typical commercial peach packing operation is shown in figure 1. The chart aids in visualizing the overall operation and emphasizes the interrelationship between activities. It can be used as a guideline for preparing a similar chart for any set of operating conditions.

Equipment Selection

Equipment requirements are determined after the hourly production rate and operation sequence are established. Equipment capacity varies throughout the packing line because fruit is removed in the sizing and grading operations. Equipment near the end of the line requires less capacity than that at the beginning. The capacity of each item of equipment is determined independently, on the basis of fruit quality and size. The following percentage distribution prevailed

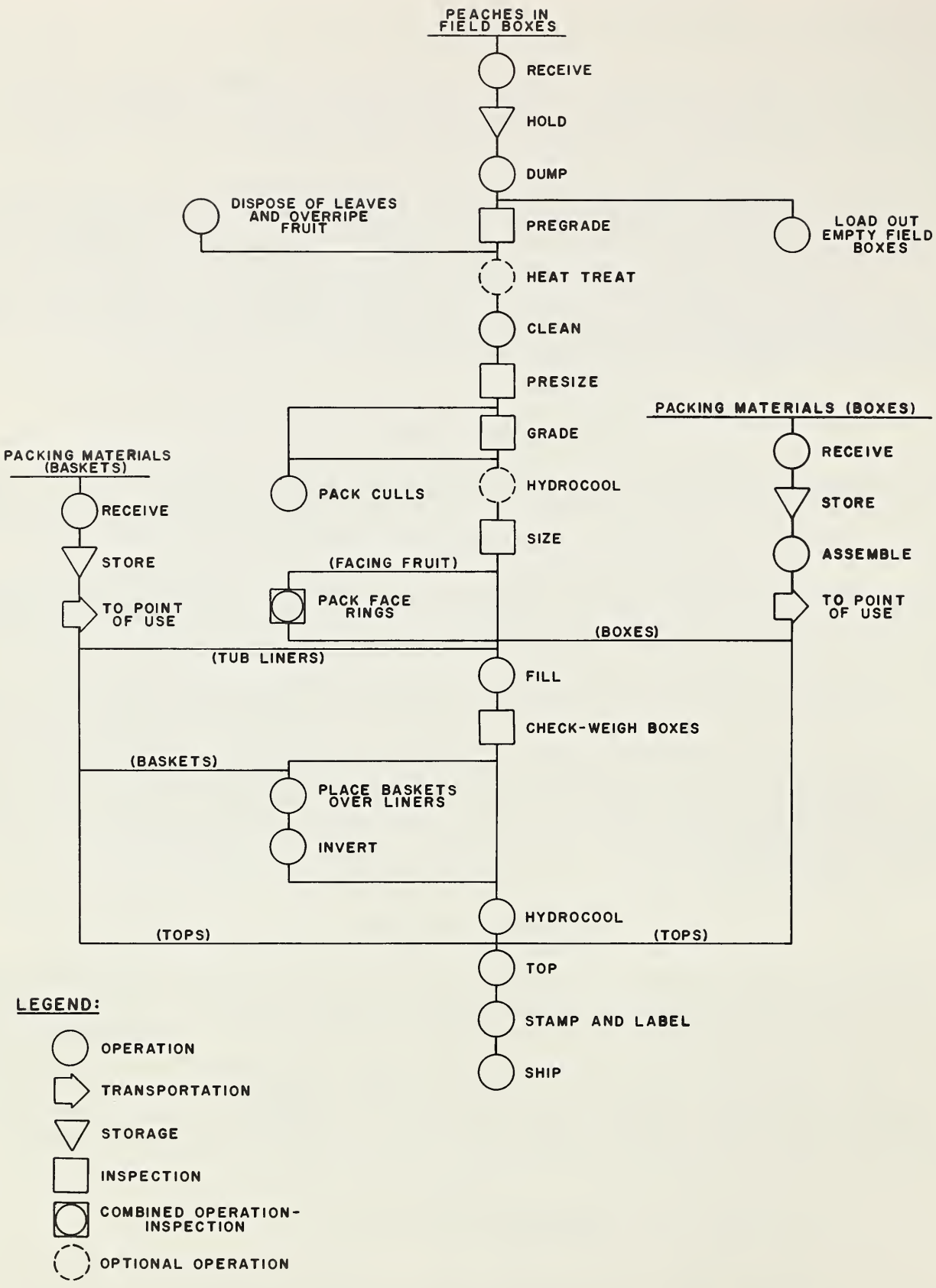

Figure 1.--This chart shows the sequence of operations for a typical commercial peach packing operation.

in the case-study plants and was used as a guideline in determining equipment capacities: (1) Overripe fruit removed by pregrading--1 percent; (2) undersize fruit removed by presizing--4 percent; (3) cull fruit removed by grading--15 percent; and (4) fruit meeting Federal grade or commercial standards--80 percent.

There are generally several types of equipment available that will do the required job. The selection should be based on an economic comparison between the alternative types available. Such an analysis was beyond the scope of this study, but factors that should be considered are: (1) Ownership and operating costs; (2) floor space requirements; (3) availability of maintenance service and replacement parts; (4) labor requirements; (5) equipment effect on product quality; and (6) adaptability to present and future operating conditions.

Analysis of Supporting Services

The supporting service areas include shipping and receiving docks, storages, employee facilities, offices, shops, and space for refrigeration and air-conditioning equipment. These areas are not directly related to packing but should be carefully planned because they are important to the overall operating efficiency of the packinghouse. The amount and type of space required and the location with respect to other plant areas should be determined for each of these activities.

Developing the Layout

An effective method of planning the layout is to use a layout board and scaled equipment templates.[3] The packing-line layout is planned first, by referring to the chart showing the sequence of operations and arranging the equipment templates on the layout board until the optimum flow of product and materials over the packing line is achieved. This procedure permits visualizing alternative equipment layouts by simply rearranging the templates. The supporting service areas are positioned around the packing line to complete the layout. The resulting layout drawing is used as a guide in preparing the plans and specifications for the plant structure.

Planning the Building

The packinghouse structure may be an open shed or an enclosed building of conventional design. While an open shed generally costs less, an enclosed building protects equipment during inclement weather and permits air conditioning for worker comfort and maintenance of product quality. Building dimensions are taken directly from the layout drawing, and floor loads are determined on the basis of present and future operating conditions. Building materials are selected on the basis of supply and cost in the geographic area under consideration. The packer should work closely with the architect during the planning stage to insure that no changes are made that will reduce the efficiency of the layout.

Selecting the Plant Site

The packinghouse site is selected after the building plans are completed. Factors that should be considered in selecting the site are: (1) Location with respect to orchards; (2) accessibility to interstate highways or railroads; (3) availability of labor; (4) availability of utilities; (5) tax rates; (6) availability of adequate space for expansion; and (7) cost of site preparation.

[3] A piece of some flat, stiff material that has been cut to the shape of the machine on the floor.

PEACH PACKINGHOUSE LAYOUT EXAMPLES

The layout procedure was used to develop layouts for three synthesized peach packing operations. The layouts incorporate equipment, conditioning processes, work methods, and operating procedures typical of the industry in different combinations of use. They illustrate the application of basic plant layout principles in the arrangement of equipment and space to achieve maximum operating efficiency. Each layout is described, equipment requirements are listed, and the steps in the packing operations are explained. Since many of the packing operations and items of equipment utilized are identical for all three layouts, all operations and equipment are described in detail in the discussion of Layout A; only those that vary are discussed in connection with Layouts B and C.

The facility design for the layout examples is basically the same even though the dimensions and location of certain activities vary. The layout examples are shown as single-story enclosed structures with a mezzanine, but they are adaptable to open sheds by eliminating exterior walls except those that enclose offices, employee facilities, and service areas. The main floor is continuous at truckbed height and is of reinforced concrete with a smooth troweled surface. Inside floors are sloped 1/4 inch per foot to trapped floor drains, and docks are sloped 1/4 inch per foot away from the building. This permits the removal of water expended during processing operations and frequent plant cleanups. The net ceiling clearance on the main floor is 21 feet. The mezzanine is of steel decking and may be covered with any suitable flooring material. It has an 8-foot ceiling clearance and is 12 feet above the main floor. Covered docks are 12 feet wide to accommodate two-way traffic, and dock heights coincide with the truckbed heights of the carriers most frequently used.

Layout A

Layout A (fig. 2) is designed for initial operation of one packing line with a rated capacity of 350 bushels packed per hour and for doubling capacity by adding a second line. Peaches are dumped onto a moving belt at the head of the packing line and they are hydrocooled after packing. The layout drawing of figure 2 shows equipment for the original packing line in solid lines and that for expansion in broken lines. For the single line, 35 workers are required when boxes are packed, and 53 when baskets are packed. For the double line, 52 workers are required for packing boxes and 85 for packing baskets.

Description of Layout

The building is 153 feet long and 95 feet wide. A receiving dock extends the length of one side. Peaches from the orchard are received at the right end of the receiving dock and moved to the temporary holding area inside. Packing materials are received and cull fruit is shipped at the left end of the dock. The remainder of dock space is used for storing empty field boxes until they are returned to the orchard for reuse.

The temporary holding area permits accumulating a backlog of peaches for the packing operation. It eliminates costly machine downtime by insuring a continuous flow of peaches to the line after operations begin. The holding area is adjacent to the dumping area and the doorway from the receiving dock. This arrangement reduces transportation distances between the receiving, holding, and dumping areas.

Maximum utilization of space in the building is not achieved until the second packing line is added. Expansion is orderly and economical because equipment for the original line does not have to be relocated when the second line is installed. The flow of product is the same before and after expansion.

The mezzanine is 60 feet long by 70 feet wide. Packing materials are moved to it by an inclined powered chain conveyor and stored until needed. They are distributed to their points

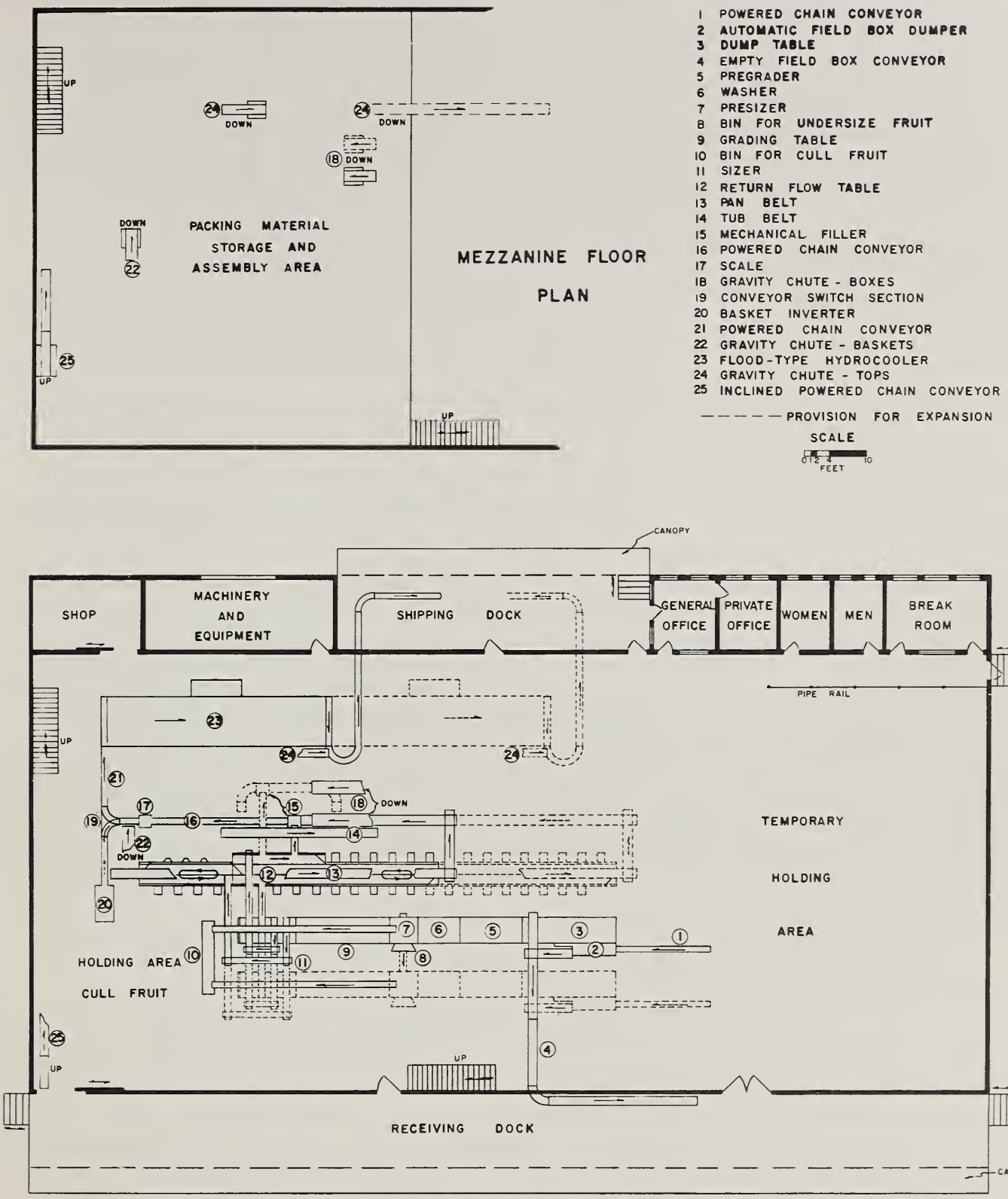

Figure 2.--Layout A.

of use on the packing line by gravity chutes. This reduces congestion on the main floor and is an economical method of distributing packing materials throughout the plant.

The shipping dock and supporting service areas are along the side of the building opposite the receiving dock. The location of the shipping dock minimizes transportation distance from the hydrocooler. Offices are located so that receiving, packing, and shipping operations can be observed simultaneously, facilitating close coordination and control of all activities. Adequate employee facilities are convenient to all work areas and plant entrances. Refrigeration equipment and the main power panel are in the machinery and equipment area near the hydrocooler. The shop provides space for repairing equipment and storing tools and spare parts.

Equipment Requirements

The items of equipment (numbered on the layout in figure 2) required for the original packing line are:

(1) A 15-foot powered chain conveyor to move field boxes of peaches to the box dumper at the head of the packing line.

(2) An automatic field-box dumper to transfer the peaches from field boxes to the packing line. The dumper is a powered chain conveyor that gradually turns the boxes on their sides as they are moved along the edge of the dump table.

(3) A 15-foot dump table with a 42-inch-wide moving belt onto which the peaches are dumped.

(4) A conveyor to move empty field boxes from the dumper to the receiving dock. This conveyor consists of 38 feet of 18-inch-wide belt conveyor and a 90-degree curve and a 25-foot straight section of gravity wheel conveyor.

(5) A 10-foot section of a float-roll grading table for the pregrading operation. A float-roll table alines the peaches between rollers and rotates them as it conveys them. The pregrader moves the peaches from the dump table to the washer.

(6) A brush-type washer and water eliminator with a capacity of 430 bushels per hour. The washer consists of a washing section and a drying (water eliminating) section. Fruit is washed by spraying it from overhead with fresh water as it moves over rotating brushes. In the drying section, excess moisture on the fruit is absorbed by rotating rollers.

(7) A 7-roll dimension-type presizer with a capacity of 430 bushels per hour and a take-away belt for undersize fruit. The presizer consists of 7 rotating sizing rollers and 7 rubber sizing belts that run parallel to the rollers. Openings between the rollers and belts are adjusted to correspond to the diameter of the minimum size of peach being packed. Peaches with diameters smaller than the openings drop onto the take-away belt underneath the presizer.

(8) A bin for accumulating undersize fruit.

(9) A 15-foot float-roll grading table with a 12-inch-wide belt above for cull fruit.

(10) A bin for accumulating cull fruit.

(11) A 6-roll dimension-type sizer capable of separating fruit into four sizes, with a capacity of 350 bushels per hour. The sizer consists of rotating sizing rollers with rubber sizing belts that run parallel to the rollers. Peaches move through the sizer in lanes formed by the openings between the rollers and belts. There are three sections of rollers with a take-away belt running below each section. A fourth take-away belt is at the end of the sizer. The size of the openings between the rollers and belts is increased in each section, so that peaches of the smallest diameter drop onto the take-away belt in the first section, and the largest peaches are run off the take-away belt at the end of the sizer.

(12) A 48-foot return-flow table consisting of three 18-inch-wide belts. Two of the belts span the length of the table; they move in opposite directions, as indicated on the layout, so that peaches are circulated from one belt to another until they are used to fill containers. Packing stations are along the length of the table on both sides. At the left end of the table on one side (see fig. 2) are gate-type fillers used with small peaches. The third belt is 15 feet long and is placed as indicated on the layout so that it serves as a reservoir for the mechanical filler (15) described below.

(13) A conveyor system, consisting of 92 feet of 18-inch-wide belt, on which empty and filled pans are moved to and from the packing stations along the return-flow table and to the mechanical filler (15). The conveyor system consists of three separate belts. The first one begins at the left end of the return-flow table and extends over the length of the table; the second section is at a right angle to the first section at the right end of the table; and the third section begins at the end of the second section and runs back to the mechanical filler (15).

(14) A 25-foot-long belt, 18 inches wide, for providing a continuous supply of empty tubs for the filling operation.

(15) A mechanical filler with a minimum capacity of twelve 1/2-bushel containers per minute. The filler consists of a pedal-operated belt that overlaps and runs at a right angle to the short reservoir belt on the return-flow table.

(16) A powered chain conveyor, 17 feet long, to move filled containers from the mechanical filler to the checkweighing station.

(17) An over-under scale to checkweigh boxes of peaches.

(18, 22, 24) Gravity chutes for moving packing materials from the mezzanine to their points of use on the packing line.

(19) A powered roller conveyor switch section at the end of conveyor (16), to route baskets to the automatic basket inverter (20) or to route boxes to the conveyor (21) that takes them to the hydrocooler. When boxes are being run, a 5-foot section of gravity wheel conveyor is attached to the end of the right curve to lower the boxes onto conveyor (21), which is at a lower elevation than conveyor (16).

(20) An automatic basket inverter.

(21) A 30-foot-long powered chain conveyor that extends from the lower level of the inverter to the hydrocooler, passing underneath the powered roller conveyor switch section (19).

(23) A 35-foot-long flood-type hydrocooler with capacity for 350 bushels of peaches per hour in 1/2-bushel baskets, with a conveyor system to move baskets and boxes from the hydrocooler to the shipping dock. The conveyor system consists of 180- and 90-degree powered curved sections of 18-inch-wide roller conveyor and 50 feet of powered chain conveyor.

(25) A 25-foot-long inclined powered chain conveyor to move packing materials to the mezzanine from the receiving dock.

An automatic assembly machine (not shown in figure 2) is provided on the mezzanine for assembling boxes.

The additional equipment and modifications required for expansion are as follows:

Duplicate equipment (except the empty field box conveyor) through the sizer (11), is installed parallel to the original line of equipment.

Take-away belts for the presizers (7) and sizers (11) are connected to operate as a unit.

The return-flow table (12) and the pan belt (13) are extended 28 1/2 and 58 feet, respectively.

A second mechanical filler (15) is installed to the left of the original one.

The flood-type hydrocooler (23) is extended 35 feet in length.

The conveyor system for moving packed containers from the hydrocooler to the shipping dock is relocated as shown in figure 2.

Packing Operations

Peach packing lines may be referred to as single or multiple lines. In a single line the items of equipment for all operations through sizing (equipment items 1 - 11 in fig. 2) are arranged so that the flow of fruit over them is in a straight line. A multiple line consists of two or more single lines. For example, layout A is a single line before expansion and a multiple line after the second line has been added. The packing operations are identical for the single and multiple lines since duplicate equipment is used on each line.

The flow of product and materials through the packing operations can be better understood by referring to the layout drawing of figure 2. Crew sizes for each operation are given in table 1, page 32.

Receiving. Layout A facilitates the use of either of the two most common methods of handling peaches during receiving operations: (1) Two-wheel clamp trucks; or (2) pallets with forklift trucks and pallet transporters.

The two-wheel clamp truck (fig. 3) is a standard hand truck with a pedal-operated clamp attachment for picking up and releasing the load. The clamp truck is operated on the receiving dock with a steel bridgeplate between the truckbed and the receiving dock. Clamp-truck operators transport stacks of four field boxes of peaches at a time from the truckbed to the temporary holding area. When peaches are needed for packing, stacks of boxes are moved by clamp truck from the temporary holding area to a position alongside the powered chain conveyor (1) that feeds the automatic box dumper.

If palletized handling is used, peaches are received at the packinghouse in unit loads of 24 field boxes on 36- by 48-inch, two-way-entry wooden pallets. Palletloads are removed from the truckbed and placed on the edge of the receiving dock by forklift truck (fig. 4). They are transported from the receiving dock to the temporary holding area by an electric pallet transporter (fig. 5). The pallet transporter is also used for moving the palletloads of peaches from the temporary holding area to a position alongside conveyor (1).

Dumping. A worker transfers field boxes of peaches from stacks or pallets on the floor to the powered chain conveyor (1) (fig. 6) that feeds the automatic field-box dumper (2). The box dumper (fig. 7) gradually turns the boxes on their sides as they are conveyed along the edge of the dump table and the peaches roll gently from the boxes onto the moving belt of the dump table (3). Empty boxes are diverted to the empty field-box conveyor (4) at the end of the dumper and moved to the receiving dock. A worker removes the boxes from the conveyor and assembles them in stacks of six[4] alongside the conveyor. Another worker transports them by clamp truck to storage on the receiving dock or to a truck waiting to return to the orchard.

Pregrading. At the end of the dump belt, peaches move onto the pregrader (5). As the peaches are conveyed over the pregrader, workers remove leaves and overripe fruit and deposit them in

[4] Six boxes are assembled so that they occupy the space generally occupied by a stack of four boxes. One box is placed on end in a second box and a third box is inverted over them.

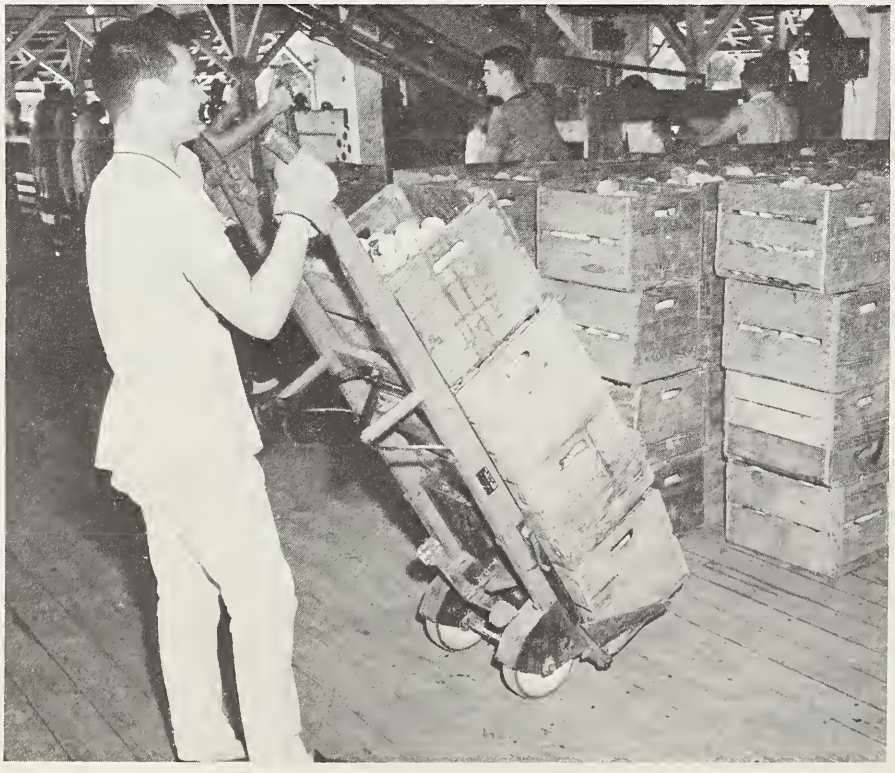

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Figure 3.--Transporting a load of four field boxes of peaches with a two-wheel clamp truck.

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Figure 4.--Removing a palletload of peaches from truckbed with an electric forklift truck.

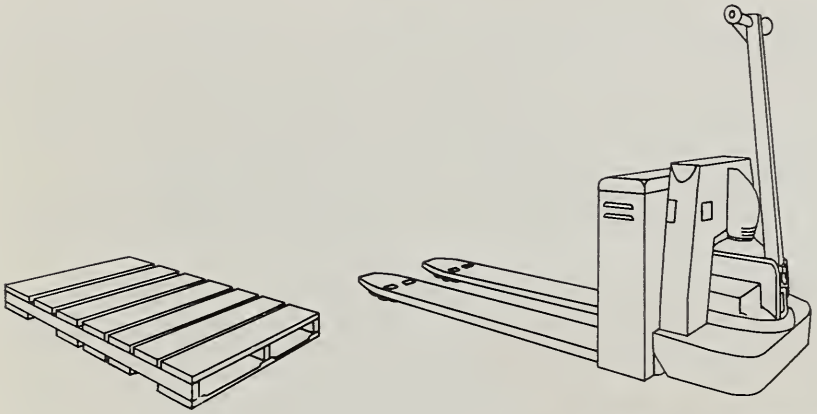

Figure 5.--Pallet and electric pallet transporter.

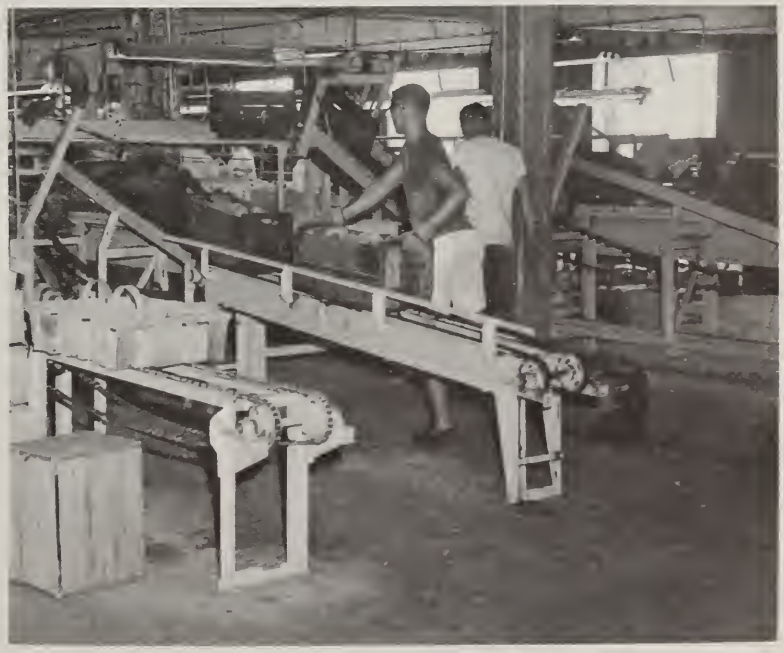

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Figure 6.--Placing field boxes of peaches on a powered chain conveyor feeding an automatic field-box dumper.

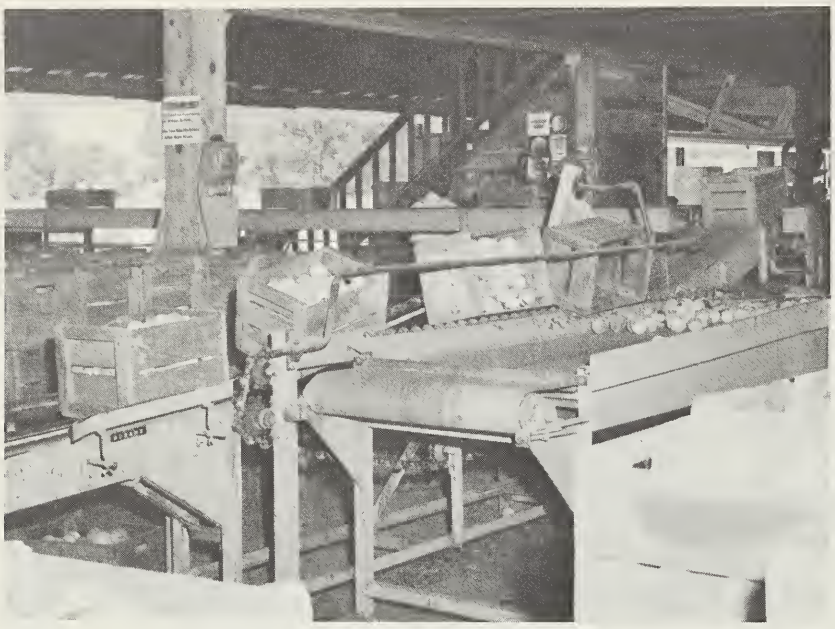

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Figure 7.--Field boxes of peaches enter on conveyor (at left) and are tilted by an automatic box dumper so that the fruit rolls onto the dump table.

field boxes on the floor (fig. 8). Empty boxes are obtained from the empty field-box conveyor (4). When boxes of overripe fruit and leaves accumulate, one of the pregrading workers transports them by clamp truck to the receiving dock for disposal.

Cleaning. Peaches move from the pregrader into the washer (6).

Presizing. From the washer, peaches move through the presizer (7) in lanes formed by openings between the rollers and the rubber sizing belts (fig. 9). Peaches smaller than the minimum size being packed for shipment drop onto the take-away belt underneath and are moved to bin (8) where they accumulate.

Grading. The peaches move from the presizer onto the float-roll grading table (9). Workers along both sides of the table remove culls and place them on the belt above the table (fig. 10). Culls are moved to bin (10).

Handling undergrade fruit. Empty field boxes are transported by clamp truck from the dock to bins (8) and (10) as boxes are needed for undergrade fruit. Field boxes are filled with undersize fruit at bin (8) and transported by clamp truck to the dock for shipment or disposal. Field boxes are filled with cull fruit at bin (10) and stacked in the holding area for cull fruit until shipped.

Sizing. Peaches move from the grader to the dimension-type sizer (11) where they are separated into four sizes on the basis of diameter (fig. 11). The take-away belts below the sizer move the peaches to the return-flow table (12), (fig. 12).

The flow of fruit from the sizer (11) to the return-flow table (12) is indicated by arrows on the layout drawing of figure 2. The smallest peaches are moved from the first section of the sizer to the left end of the return-flow table. They are confined to this end of the table by a metal partition and circulate as shown until packed into baskets or boxes.

When baskets are being packed, peaches of the next size are moved from the second to the fourth section of the sizer and mixed with the largest peaches. These peaches move directly to the short reservoir belt of the mechanical filler (15). Peaches from the third section of the sizer are moved to the belt of the return-flow table that moves to the right and are used for facing (see description following). At the end of this belt, they are diverted by a metal partition onto the belt on the opposite side of the table that moves to the left. Peaches that are not used for facing continue on the belt moving to the left until diverted by a metal partition onto the reservoir belt of the filler. They mix with peaches of the second and fourth sizes and circulate as shown until used for filling.

When boxes are being packed, peaches of the second, third, and fourth sizes are mixed together and moved directly to the reservoir belt of the mechanical filler (15).

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Figure 8.--Workers removing leaves and overripe fruit.

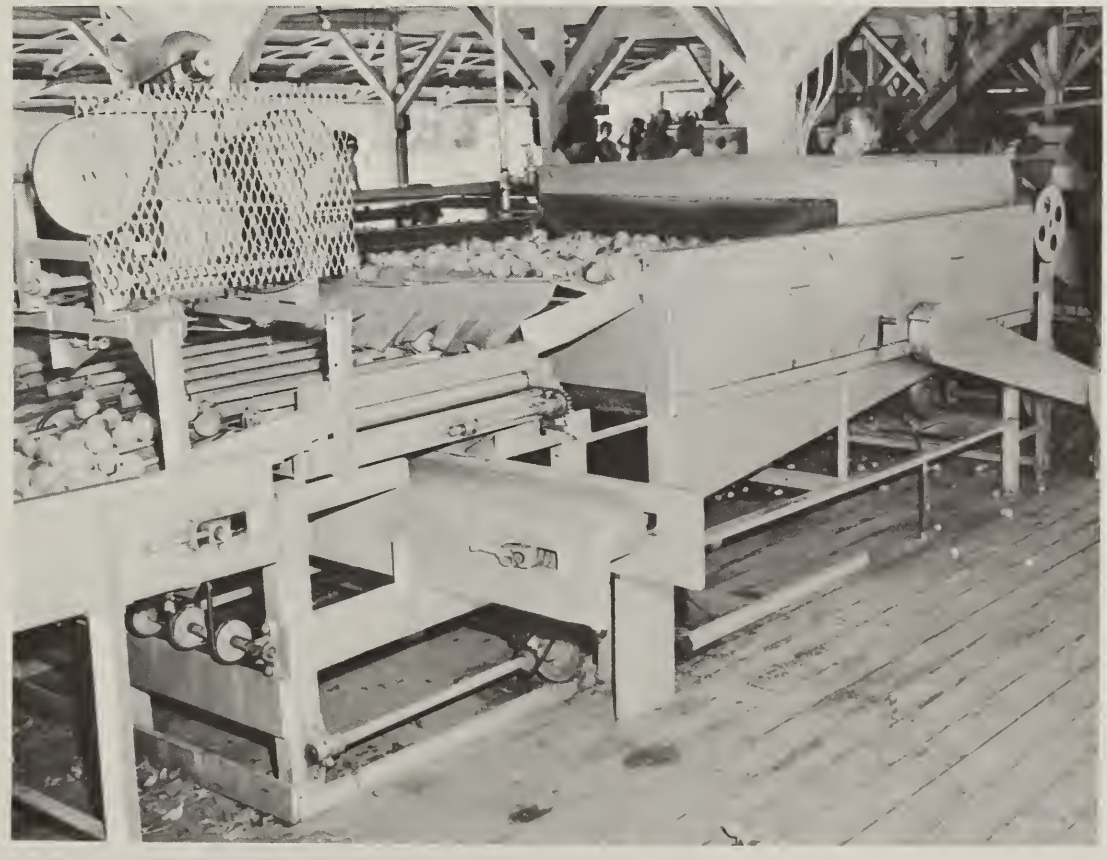

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Figure 9.--Peaches leave the washer (right) and enter the 7-roll presizer. Undersized fruit drops through while the larger fruit moves onto the float-roll sorting table (left).

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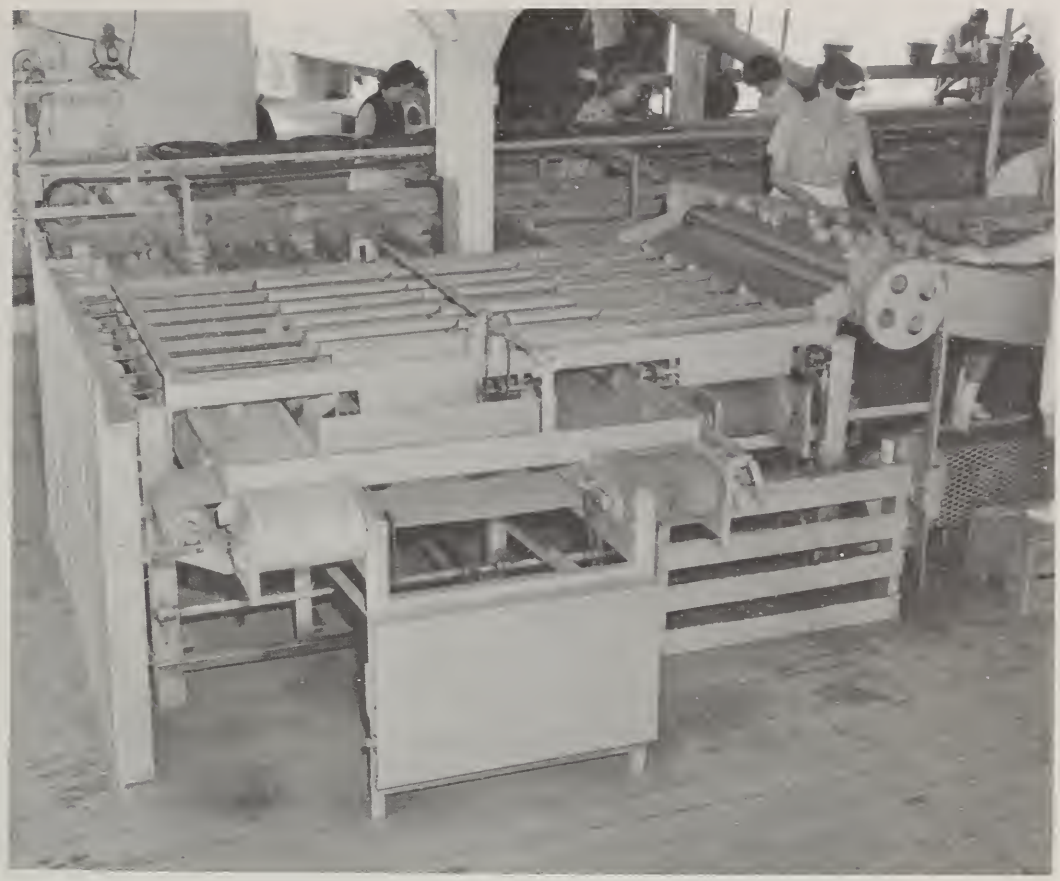
Figure 10.--A float-roll grading table with cull belt overhead.

Facing. Facing is required only when baskets are filled. Peaches of uniform size and color are packed into round concave metal pans. These peaches will be on top in the baskets when they are shipped, giving the pack an attractive appearance. Peaches from the third section of the sizer are used for facing. Facing peaches are moved past workers along both sides of the return-flow table. Workers obtain empty pans from the pan belt (13) and position them on the racks along the edge of the table. They select peaches from the moving belt and pack them into the pans. Filled pans are returned to the pan belt and are moved to the mechanical fillers (15).

Supplying packing materials. Packing materials are stored on the mezzanine. Baskets, liners, and tops are moved from storage to the gravity chutes. Bundles of 250 liners are moved by box chute (18) to the main floor where they are used for lining tubs. Workers at chutes (22) and (24) keep them filled with baskets and tops, respectively.

Boxes and their tops are received and stored in bundles of 5 and 10, respectively. Boxes are assembled by workers at an automatic assembly machine. The boxes are formed by folding the sides and ends together and partially engaging two pairs of wire loops that hold them together. The boxes are placed in the assembly machine which secures the wire loops. Tops are assembled by folding the sides and ends together and engaging tabs that hold them together. Workers at chutes (18) and (24) keep them filled with boxes and tops, respectively.

Filling. A preliminary tubbing operation is required when baskets are being filled (fig. 13). Stiff paper liners are inserted in the basket-shaped metal tubs on the tub belt (14). The lined tubs are removed from the right end of the tub belt and placed on the pans of facing peaches on the belt moving toward the mechanical fillers (15). The tub assemblies are conveyed by the pan belt to a position beneath the end of the filling belt of the mechanical filler. If the second filler (shown in broken lines) is also being used, tub assemblies are manually transferred from the pan belt to the conveyor that moves them to the filling position of this filler. The tub assemblies are filled with peaches at the mechanical fillers. Tub assemblies filled at the first filler move directly onto conveyor (16) and those filled at the second filler are manually transferred to it.



BN-28572

Figure 11.--A 6-roll dimension-type sizer.

BN-28571

Figure 12.--A typical return-flow table with two parallel belts that move peaches in opposite directions.

BN-28562

Figure 13.--A typical work station layout for filling baskets with peaches at a mechanical filler. Worker at top right inserts stiff paper liners in metal tubs. Worker at bottom right positions lined tubs on pans of facing peaches moving toward the filler on the pan belt. Worker at left front is filling tub with peaches. After the tub is filled, the worker in center (with hand behind head) will remove the tub from the peaches and return it to the tub belt for reuse.

The metal tubs are removed from the assemblies and the peaches are supported on the pans by the stiff paper liners. The metal tubs are placed on the left end of the tub belt (14) for reuse.

The peaches are moved by conveyor (16) to the basketing area. Here a worker obtains baskets from chute (22) overhead, and places them over the peaches on the pans as they move past. The baskets of peaches are upside down on the pans at this point. They are routed by the conveyor switch section (19) to the conveyor that moves them to the basket inverter (20). The baskets enter the top level of the inverter (fig. 14) and are rotated 180 degrees. They move from the lower level of the inverter (fig. 15) to conveyor (21) in an upright position with the pans on top. As the baskets leave the inverter a worker removes the pans from the tops of the baskets and places them on the left end of the pan belt (13) for reuse (fig. 15). The baskets of peaches move by conveyor (21) underneath the conveyor switch section (19) to the hydrocooler.

Tubs are filled with small peaches at three gate-type fillers along the left end of the return-flow table where the belt is moving to the left. Tubs and liners are provided at the work station. Pans of facing peaches are obtained from the pan belt (13) and placed on racks beneath the pedal-operated gates. The tubs are lined and positioned on the pans. The gates are opened and peaches are raked by hand from the belt into the tubs. Filled tub assemblies are placed on conveyor (16) and the tubs are removed and reused at the work station. From this point, the small peaches are handled in the same manner as the other sizes.

BN-28569

Figure 14.--Baskets of peaches entering a basket inverter.

BN-28561

Figure 15.--A basket of peaches in an upright position with pan on top is shown emerging from the basket inverter at the right. The worker is transferring pans from the tops of the baskets to the pan belt for reuse.

Boxes are filled by weight rather than by volume. The three largest sizes of peaches are used to fill boxes at the mechanical filler (15). Boxes are obtained from chute (18) and positioned on the conveyors leading to the fillers. Boxes are filled with peaches to the approximate required weight[5] at the mechanical fillers. Boxes filled at the mechanical filler move directly onto conveyor (16); if the second filler (shown in broken lines) is also used, boxes are manually transferred to the conveyor.

Boxes are filled with small fruit at the gate-type fillers along the left end of the return-flow table. The basket chute (22) is used to move boxes for small peaches from the mezzanine to the

[5] Boxes are generally filled with 25 or 38 pounds of peaches (equivalent to 1/2- or 3/4-bushel baskets).

main floor. Boxes are obtained from the chute and stacked on the floor at the work station until needed. They are positioned on racks underneath the gates, filled to the approximate required weight, and then transferred to conveyor (16). The boxes of small peaches continue on conveyor (16) and from this point are handled in the same manner as peaches of the other sizes.

Boxes of peaches advance to the over-under scale (17). They are checkweighed (fig. 16) and peaches are added or removed to obtain the correct weight. The boxes are diverted to the right-hand curve of the conveyor switch section (19) and move down the 5-foot section of gravity wheel conveyor (not shown on the layout drawing) to conveyor (21) to the hydrocooler.

Hydrocooling. Containers of peaches are moved on conveyor (21) to the flood-type hydrocooler (23). Workers transfer baskets (fig. 17) or boxes to the slatted chain conveyor inside the hydrocooler. The peaches are sprayed with chilled water from overhead as they move through the cooling tunnel. The temperature of the fruit is reduced to a safe level for shipment with a minimum of spoilage loss. Workers at the other end of the hydrocooler transfer baskets or boxes (fig. 18) to the conveyor that moves them to the shipping dock for shipment.

Topping. Tops are applied to containers on the conveyor as they leave the hydrocooler. Basket tops are obtained from chute (24). Workers stationed alongside the conveyor apply tops to the baskets moving past them en route to the shipping dock. Tops are secured to the baskets at four points. Two protruding center slats on the tops are inserted underneath the two wire carrying handles on opposite sides of the baskets by using a spade-like hand tool (fig. 19). Tops are also secured to the baskets at two points at right angles to the protruding center slat by two sets of wire loops. The wire loops on the baskets are pulled through and bent over the wire loops on the tops with a hand tool designed for this purpose.

Tops are applied to boxes at the same point in the line. A worker obtains tops from chute (24) and places them on the boxes that are moving along on the conveyor (fig. 20). Tops are secured to the boxes at both ends by tabs on the tops that engage the underside of the top cleats on the boxes.

Stamping, labeling, and tallying. A typical work station layout for these operations is shown in figure 21. A worker (not shown in figure) stamps containers moving from right to left on the conveyor to show peach variety, grade, and size and the word "hydrocooled." One worker feeds brand labels through an electric glue applicator, another places labels on containers, and another tallies the grade and size of each container.

Shipping. The packed containers are conveyed through a portal in the wall onto the shipping dock. Containers are transferred to portable powered chain or gravity roller conveyors that move them into refrigerated trailers where they are stacked for shipment.

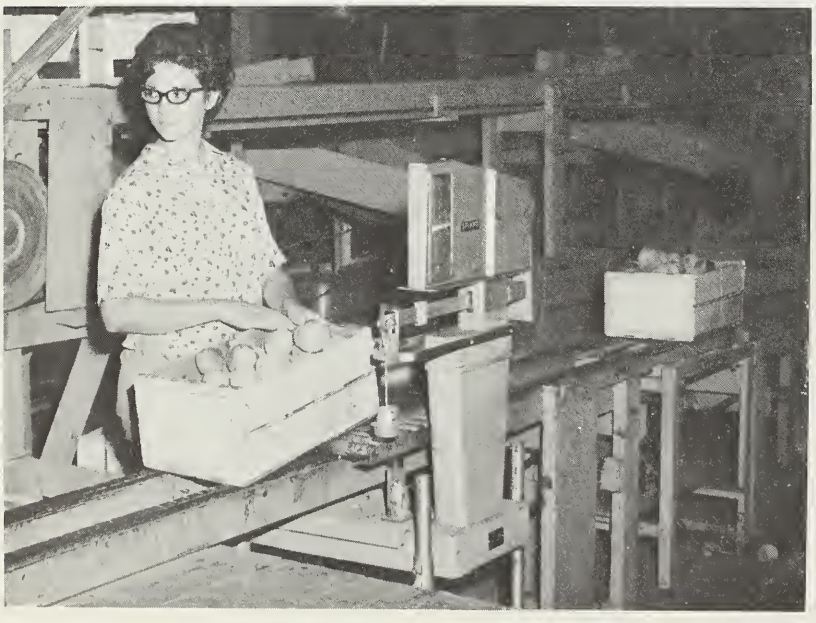


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Figure 16.--Checkweighing station. Worker is moving box from scale after weighing it.

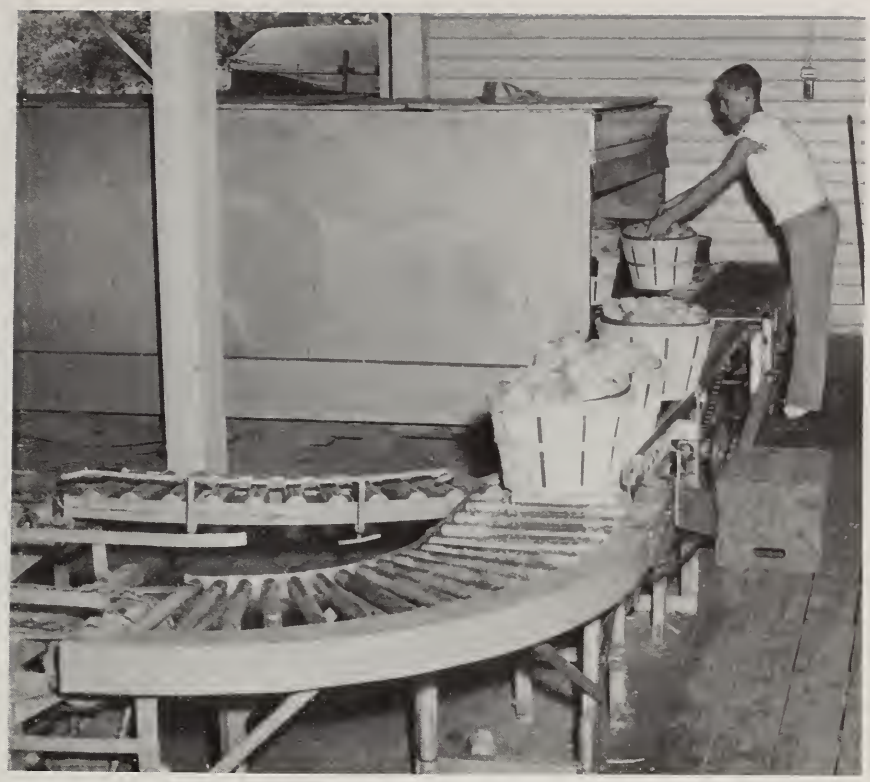

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Figure 17.--Worker loading a flood-type hydrocooler with peaches in baskets.

BN-28570

Figure 18.--Unloading boxes from a flood-type hydrocooler.

BN-28574

Figure 19.--Workers securing tops to baskets by inserting protruding slats underneath wire carrying handles on opposite sides of the baskets.

BN-28563

Figure 20.--A worker applying tops to boxes.

BN-28568

Figure 21.--A typical work station layout for stamping and labeling operations.

Layout B

Layout B (fig. 22) is a one-line operation with a rated capacity of 450 bushels packed per hour. With this layout, 65 workers are required when baskets are packed and 42 when boxes are packed.

In Layout B peaches are dumped into a dump tank (3) that occupies approximately the same amount of floor space as the dump table in Layout A. Peaches are hydrocooled in bulk before packing. Effective space utilization is achieved initially, because increased production does not require additional equipment.

Description of Layout

The building is 177 feet long and 81 feet wide. Layout B is similar to Layout A in some respects, but the platform for holding empty field boxes is located on the side of the building opposite the receiving dock. The locations of the receiving dock, temporary holding area, and the platform for holding empty field boxes provide a straight-line flow of field boxes between these plant areas.

Service areas are located near the production activities they support. The shipping dock is located to minimize transportation distance between it and the end of the packing line. The shipping and receiving docks are placed at opposite ends of the same side of the building to eliminate interference between shipping and receiving operations. Offices are centrally located with respect to all plant activities, facilitating close coordination and control. Employee facilities are convenient to all plant areas, reducing the time workers are away from their work stations. The machinery and equipment area is near the hydrocooler, and the shop is located near the heaviest concentration of machinery and equipment.

The mezzanine for storing and handling packing materials is 70 feet long and 50 feet wide. Packing materials are received at the dock adjacent to the machinery and equipment room and moved to the mezzanine by inclined powered chain conveyor (25). They are assembled here, and distributed to their points of use by gravity chutes as in Layout A.

Equipment Requirements

The items of equipment (numbered on the layout in figure 22) required for Layout B are:

(1) A 25-foot powered chain conveyor to move field boxes of peaches to the box dumper.
(2) An automatic field-box dumper like the one in Layout A to transfer the peaches from field boxes to the packing line.
(3) A dump tank to receive the peaches as they are dumped and move them to the pregrader. The dump tank is a tank filled with water that is circulated to move the peaches to the pregrader (5) that extends into the tank.
(4) A conveyor to move empty field boxes from the dumper to the platform. The conveyor consists of a 15-foot inclined section of 18-inch-wide belt and a 90-degree curve and 20-foot inclined straight section of gravity wheel conveyor.
(5) A 10-foot section of a float-roll grading table for the pregrading operation that extends into the dump tank; the pregrader alines the peaches between rollers and rotates them as it conveys them from the dump tank to the washer.
(6) A brush-type washer and water eliminator with a capacity of 550 bushels per hour.
(7) An 8-roll dimension-type presizer with a capacity of 550 bushels per hour and a take-away belt for undersize fruit. The presizer is identical to the one used in Layout A except there are 8 rotating sizing rollers and 8 rubber sizing belts.
(8) A bin for accumulating undersize fruit.
(9) A 35-foot-long bulk hydrocooler with a capacity of 535 bushels of peaches per hour.
(10) A water eliminator, which is the drying section of a washer, to remove excess moisture from the fruit surface before grading.
(11) A 20-foot float-roll grading table with a 12-inch-wide belt above for cull fruit.

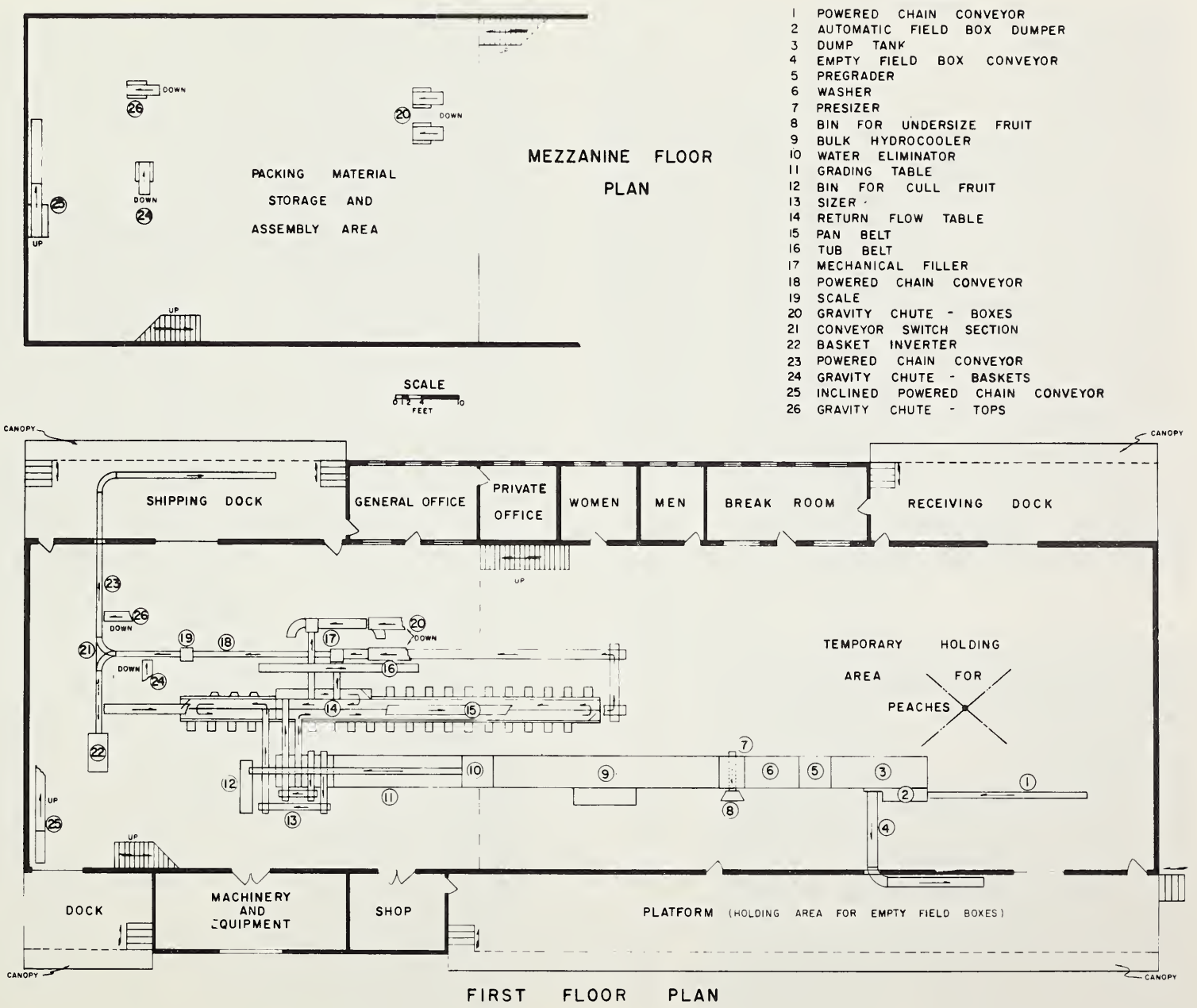

Figure 22.--Layout B.

(12) A bin for accumulating cull fruit.
(13) An 8-roll dimension-type sizer capable of separating fruit into four sizes, with a capacity of 450 bushels per hour. There are four take-away belts for moving the fruit of each size to the return-flow table.
(14) A 65-foot return-flow table consisting of three 18-inch-wide belts. Two of the belts span the length of the table; the third belt is 15 feet long and serves as a reservoir for the mechanical filler. The flow of fruit over the table is identical to that in Layout A.
(15) A belt conveyor system like the one in Layout A for moving empty and filled pans to and from the packing stations along the return-flow table and to the mechanical fillers (17). The conveyor system for this layout consists of 135 feet of 18-inch-wide belt.
(16) A 25-foot-long belt, 18 inches wide, for providing a continuous supply of empty tubs for the filling operation.
(17) Two mechanical fillers, each with a minimum capacity of eight 1/2-bushel containers per minute.
(18) A powered chain conveyor, 33 feet long, to move filled containers from the mechanical fillers to the checkweighing station.
(19) An over-under scale to checkweigh boxes of peaches.
(20, 24, 26) Gravity chutes for moving packing materials from the mezzanine to their points of use on the packing line.
(21) A powered roller conveyor switch section at the end of conveyor (18), like the one in Layout A, to route baskets to the inverter or boxes to the shipping dock.
(22) An automatic basket inverter.
(23) A conveyor for moving packed containers to the shipping dock. The conveyor consists of 62 feet of powered chain and a 90-degree curved section of powered roller conveyor. It starts at the inverter and runs underneath the switch section, through a portal in the wall, and along the edge of the shipping dock.
(25) A 25-foot-long inclined powered chain conveyor to move packing material to the mezzanine.

An automatic assembly machine (not shown in figure 22) is provided on the mezzanine for assembling boxes.

Packing Operations

A number of the equipment items and the equipment arrangement of Layout B are similar to those of Layout A; therefore, the flow of product and materials and packing operations are similar. For this reason, only the operations that are different are described in detail in this section. The flow of product and materials through the packing operations can be better understood by referring to the layout drawing of figure 22. Crew sizes for each operation are given in table 1, page 32.

Peaches are received in field boxes and moved to the temporary holding area as in Layout A. From here, they are moved to a position alongside conveyor (1). One box at a time is transferred to conveyor (1) and moved to the automatic field-box dumper (2).

The automatic box dumper gradually turns the boxes on their sides as they are conveyed along the edge of the dump tank and the peaches roll gently out of the boxes into the water. The water in the tank is circulated so that the peaches are moved toward the pregrader (5) that extends into the tank. The peaches aline themselves between the rollers of the pregrader and are rotated as they are moved out of the water. Empty field boxes are moved by the empty field-box conveyor (4) to the platform for holding or return to the orchards for reuse.

The peaches continue over the pregrader (5), through the washer (6), and over the presizer (7). The peaches move from the presizer into the bulk hydrocooler (9). A bulk hydrocooler consists of a cooling tunnel through which loose fruit is moved on an inclined slatted chain conveyor. The peaches are initially immersed in agitated chilled water. As they are moved through the tunnel, they are gradually lifted out of the water and sprayed with chilled water from

overhead. At the end of the hydrocooler, the peaches are transferred to the water eliminator (10). Moisture is removed from the fruit surface as it moves over rotating foam rubber absorber rollers.

The fruit is then graded, sized, packed, and shipped as in Layout A.

Layout C

Layout C (fig. 23) is a one-line operation with a rated capacity of 450 bushels packed per hour. Production can be increased by increasing the hours of plant operation. The layout is designed to achieve maximum operating flexibility and maintenance of product quality. With this layout, 66 workers are required when baskets are packed and 45 when boxes are packed. As in Layout B, the peaches are hydrocooled in bulk before packing.

A rotary packing table is provided for packing peaches of either of the two smallest size groups into consumer packs without interrupting other plant operations.

The cooler provides 1,369 square feet of refrigerated storage, which permits accumulating a backlog of packed peaches. As a result, shipping schedules are not controlled by the production rate of the packing line. Refrigerated storage permits operating the packing line even when carriers are not available and permits packing during regularly scheduled hours each day throughout the packing season.[6] This reduces costly worker and machine downtime and enhances worker morale.

Description of Layout

The building for Layout C is 211 feet long and 76 feet wide. The flow of produce and materials and the relative location of the various plant areas are essentially the same as for Layout B.

The shipping dock is adjacent to the truckloading area, the railroad siding at the left end of the packinghouse, and the cooler. This permits shipping peaches by rail and truck simultaneously either from the cooler or directly from the packing line and provides a considerable amount of flexibility in scheduling shipping operations.

The refuse room, adjacent to the machinery and equipment room, provides space for holding refuse accumulated during operations and plant cleanups. Packing materials are stored on the mezzanine, which is 90 feet long and 50 feet wide. They are distributed to their points of use on the main floor by gravity chutes as in Layouts A and B.

Equipment Requirements

The items of equipment (numbered on the layout in figure 23) required for Layout C are:

(1) A 20-foot powered chain conveyor to move field boxes of peaches to the box dumper.

(2) An automatic field-box dumper to transfer peaches from the field boxes to the packing line.

(3) A dump tank into which the peaches are dumped. As in Layout B, the dump tank is filled with water that is circulated to move the peaches to the pregrader (5) that extends into the tank.

(4) A conveyor to move empty field boxes from the dumper to the platform for holding. This conveyor consists of a 15-foot inclined section of 18-inch-wide belt and a 90-degree curve and 20-foot straight section of gravity wheel conveyor.

(5) A 10-foot section of a float-roll grading table for the pregrading operation. The pregrader extends into the dump tank and alines the peaches between rollers and rotates them as it moves them out of the water.

(6) A brush-type washer and water eliminator with a capacity of 550 bushels per hour.

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[6] The refrigerated storage can also be used to hold a supply of fruit from the orchard overnight so the packinghouse can start operating early in the morning.

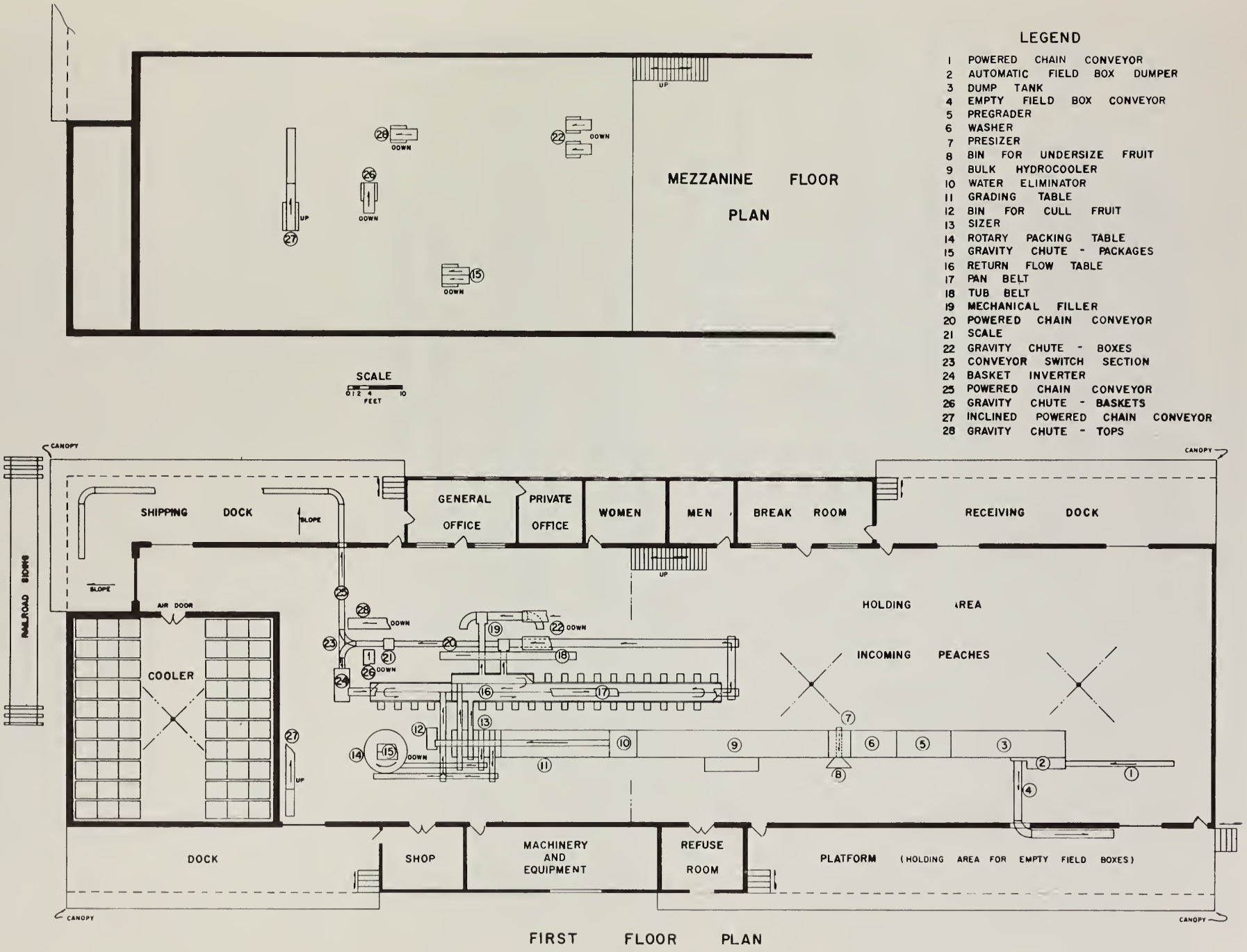

Figure 23.--Layout C.

(7) An 8-roll dimension-type presizer with a capacity of 550 bushels per hour.
(8) A bin for accumulating undersize fruit.
(9) A 35-foot-long bulk hydrocooler with a capacity of 535 bushels per hour.
(10) A water eliminator to remove moisture from the fruit surface before grading.
(11) A 20-foot float-roll grading table with a 12-inch-wide belt above for cull fruit.
(12) A bin for accumulating cull fruit.
(13) An 8-roll dimension-type sizer capable of separating fruit into four sizes, with a capacity of 450 bushels per hour. Take-away belts for fruit of the two smallest sizes are equipped with portable gates that permit routing fruit of either of these sizes to the return-flow table (16) or the rotary packing table (14).
(14) A rotary packing table, 8 feet in diameter, from which peaches are packed into consumer packs.
(15, 22, 26, 28) Gravity chutes for moving packing materials from the mezzanine to their points of use on the packing line.
(16) A 65-foot return-flow table identical to the one in Layout B.
(17) A belt conveyor system like the ones in Layouts A and B, for moving empty and filled pans to and from the packing stations along the table to the mechanical fillers (19). The conveyor system for this layout consists of 125 feet of 18-inch-wide belt.
(18) A 25-foot-long belt, 18 inches wide, for providing a continuous supply of tubs for the filling operation.
(19) Two mechanical fillers, each with a capacity of eight 1/2-bushel containers per minute.
(20) A powered chain conveyor, 25 feet long, to move filled containers from the mechanical fillers to the checkweighing station.
(21) An over-under scale for checkweighing filled boxes.
(23) A powered roller conveyor switch section identical to the ones in Layouts A and B for routing baskets to the inverter or boxes to the shipping dock.
(24) An automatic basket inverter.
(25) A powered chain conveyor that extends from the lower level of the basket inverter and runs underneath the conveyor switch section to the shipping dock. When boxes are being packed, a 5-foot section of gravity wheel conveyor is attached to the right-hand curve of the conveyor switch to lower them to conveyor (25) below.
(27) A 25-foot-long inclined powered chain conveyor to move packing materials to the mezzanine.

An automatic assembly machine (not shown in figure 23) is provided on the mezzanine for assembling boxes.

Packing Operations

Many of the equipment items used in Layout C and the equipment arrangement are similar to those of Layouts A and B; therefore, the flow of product and materials through the packing operations are similar. For this reason, only the operations that are different are described in detail in this section. The flow of product and materials through the packing operations can be better understood by referring to the layout of figure 23. Crew sizes for each operation are given in table 1, page 32.

Peaches are received in field boxes and moved to the temporary holding area as in Layouts A and B. When needed for packing, they are moved to a position alongside conveyor (1). A worker transfers the boxes to the conveyor, which moves them to the automatic field-box dumper (2). The box dumper gradually turns the boxes on their sides as they are conveyed along the edge of the dump tank (3), causing the peaches to roll gently from the boxes into the water. Circulating water moves the peaches through the tank to the pregrader (5) that extends into the end of the tank. The pregrader alines the peaches between rollers and rotates them as it moves them out of the water. Empty field boxes are diverted from the box dumper to the conveyor (4) that moves them to the platform for holding until reuse.

Peaches continue over the packing line as in Layout B until they reach the sizer (13). The sizing operation is identical to that of Layout B except this layout provides the capability of packing fruit of either of the two smallest sizes (that fruit released on the first or second take-away belts) into consumer packs without interrupting other plant operations. This fruit is moved from the sizer to the rotary packing table (14) and circulates on the rotating table surface until packed. Workers stationed around the table handpack this fruit into consumer packs. Packing materials are supplied to the work station by gravity chute (15). Packed containers are palletized and transported by pallet transporter directly to the shipping dock or to the cooler. Peaches of the other sizes are moved to the return-flow table (16) and packed in baskets or boxes as in Layout B.

Layout C provides a considerable degree of flexibility in shipping operations. For example, after containers are topped adjacent to the chute (28), all or part of them may be removed from conveyor (25) and palletized. Pallet loads are moved by electric pallet transporter to the cooler for holding until they are shipped. Containers that are not removed at this point continue on conveyor (25) through the portal in the wall to the shipping dock. Here, containers can be loaded into trucks or moved along the length of the dock, turned 90 degrees, and moved along the edge of the dock adjacent to the railroad siding at the left end of the packinghouse. This arrangement permits shipping by truck and rail simultaneously.

ESTIMATED CREW SIZES FOR LAYOUT EXAMPLES

The estimated number of workers required to operate the layout examples when packing peaches in baskets and boxes at the specified production rates are shown in table 1. Crew sizes are based on the average number of workers utilized for the various operations in case-study plants operating at similar production rates. Labor requirements for packing baskets are greater than for packing boxes in all layouts, because baskets are faced, but boxes are not. The number of workers required for some jobs does not vary proportionately with production. This indicates that some workers are not fully utilized, but have to be available. It should be pointed out that these crew sizes assume normal operating conditions; variations in the quality and size of incoming fruit can alter them slightly. The estimated crew sizes are presented as guidelines for layout planning and not as production standards. They will aid the packer in estimating labor requirements for similar peach packinghouse layouts.

TABLE 1.--Estimated number of workers required for 3 peach packinghouse layout examples

Operation	Layout A[1]				Layout B[2]		Layout C[2]	
	One line		Two lines					
	Baskets	Boxes	Baskets	Boxes	Baskets	Boxes	Baskets	Boxes
Tally and check peaches received	1	1	1	1	1	1	1	1
Transport peaches from trucks to holding area to packing line with clamp trucks	2	2	3	3	3	3	3	3
Load conveyor feeding automatic box dumper	1	1	2	2	1	1	1	1
Handle empty field boxes on receiving dock or platform	2	2	2	2	2	2	2	2
Pregrade	2	2	4	4	3	3	3	3
Grade[3]	6	6	12	12	8	8	8	8
Pack and handle overripe, undersize, and cull fruit	2	2	2	2	2	2	2	2
Pack consumer pack[4]	--	--	--	--	--	--	2	2
Face[5]	18	--	35	--	23	--	21	--
Fill	4	3	6	5	6	5	6	5
Checkweigh boxes	--	1	--	2	--	1	--	1
Supply packing materials	2	6	3	8	3	8	4	9
Place baskets on peaches	1	--	1	--	1	--	1	--
Transfer pans from baskets to pan belt	1	--	1	--	1	--	1	--
Hydrocool	1	1	2	2	--	--	--	--
Top	3	1	4	2	4	1	4	1
Stamp, label, and tally[6]	3	3	3	3	3	3	3	3
Load out	2	2	2	2	2	2	[6]2	[6]2
Supervise	1	1	1	1	1	1	1	1
Maintenance	1	1	1	1	1	1	1	1
Total crew	53	35	85	52	65	42	66	45

[1]Production capacity of packing line is 350 bushels packed per hour for the one-line operation and 700 for the two-line operation.

[2]Production capacity of packing line is 450 bushels packed per hour.

[3]Based on an average production rate of 70 bushels per hour per grader.

[4]Based on the assumption that peaches released at the second section of the sizer are packed in a consumer pack.

[5]Based on an average production rate of 40 pans packed per hour per worker.

[6]The typical work station described earlier shows 4 workers, but 3 are recommended.

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